Hypotrochoid Curves as a Web App

The Beauty of Sinus And Cosinus

Vojta FILIPEC

15.3. 2024, Friday, 10:15am

Abstract

This is a talk of a data scientist who loves to play with math, enjoys creating visualisations in Jupyter Notebook but has limited capabilities of sharing his notebooks online. I will explain what hypotrochoid curves are, how to plot them in Jupyter Notebook, then how remake a notebook into an interactive in-browser app (using ipython widgets and voila), and finally how to publish this app via Binder. I hope this will be useful for anyone who wants to share his/her notebooks with broad audience.

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Spirograph

Web App

Aboutme

☢ nuclear physicist

∫ data scientist

✉ linkedin.com/in/vojtech-filipec/

PR github.com/vojtech-filipec/

↳ find these slides there

Abstract

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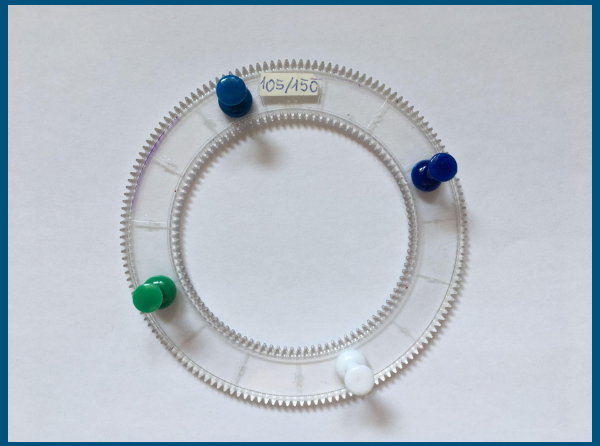
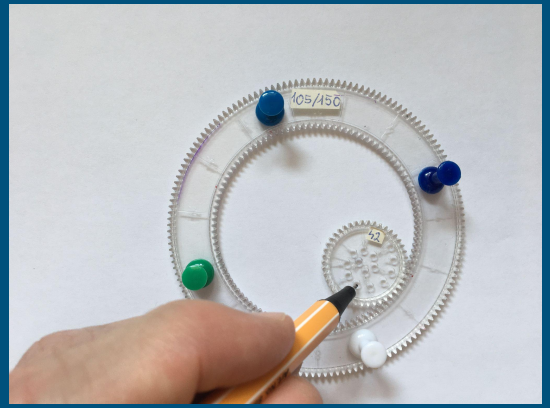
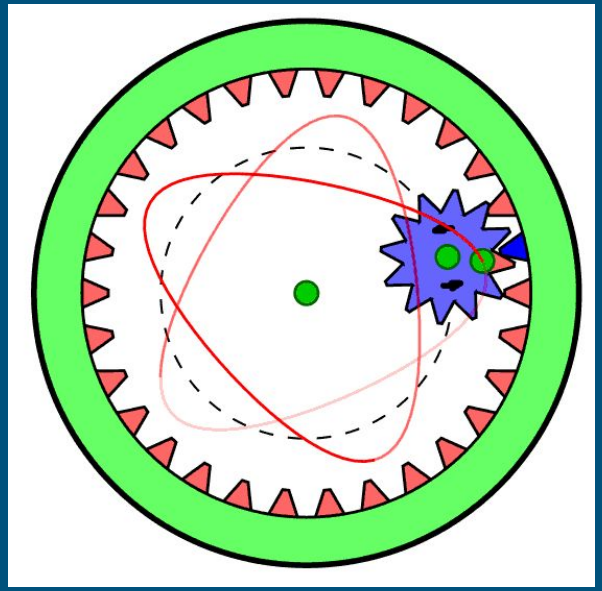
Spirograph





https://en.wikipedia.org/wiki/Spirograph



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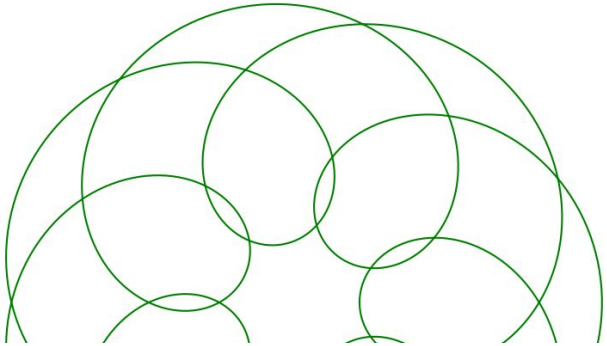
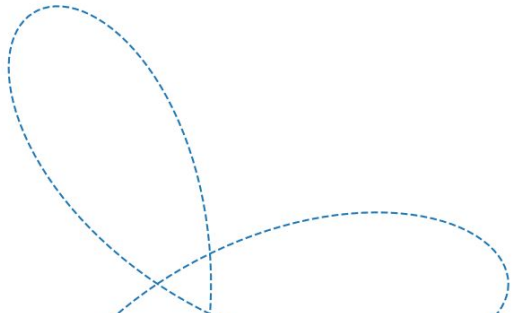
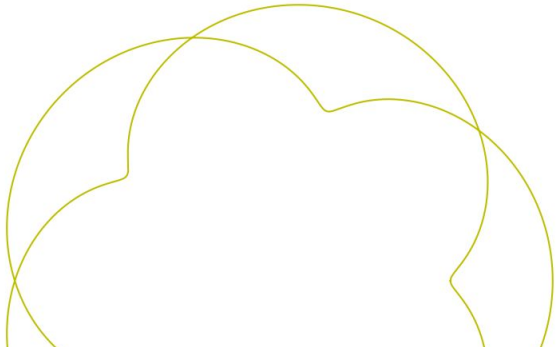
R=7, r=9, d=3



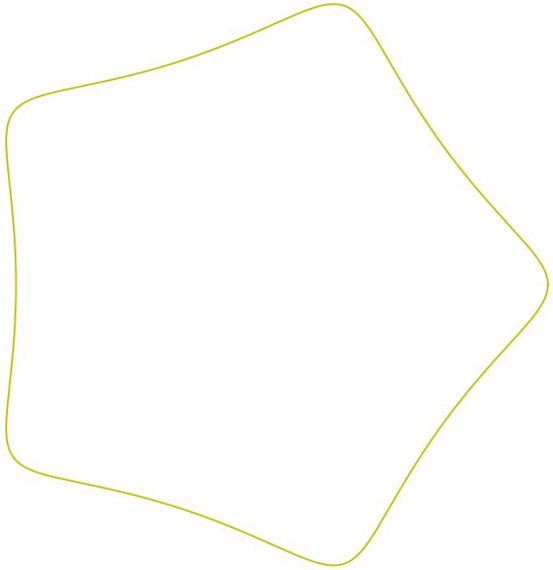
R=12, r=4, d=9



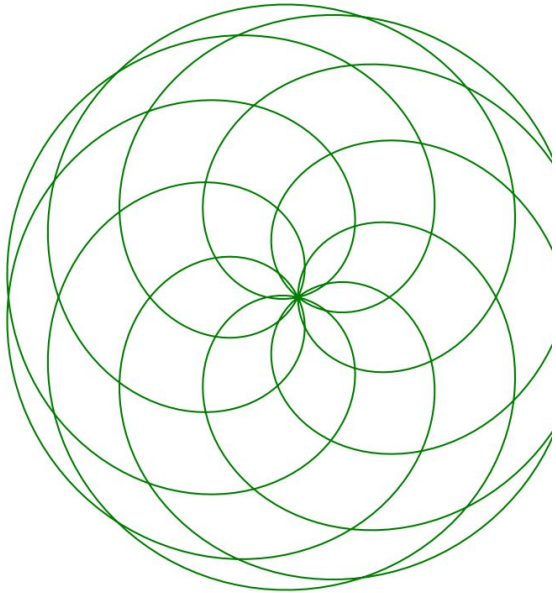
R=5, r=7, d=9



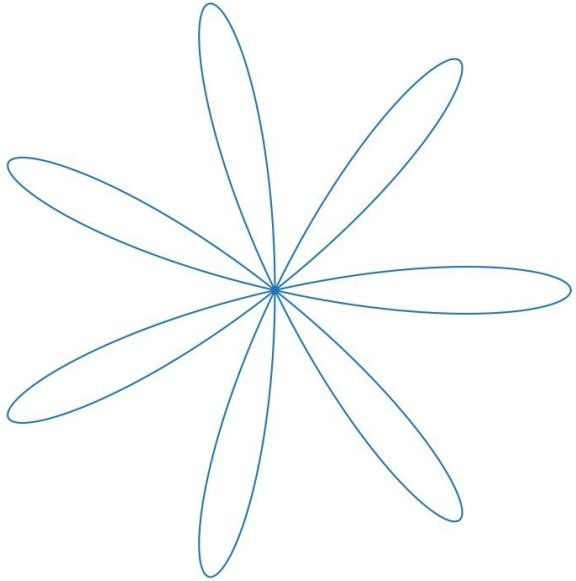
R=5, r=4, d=9



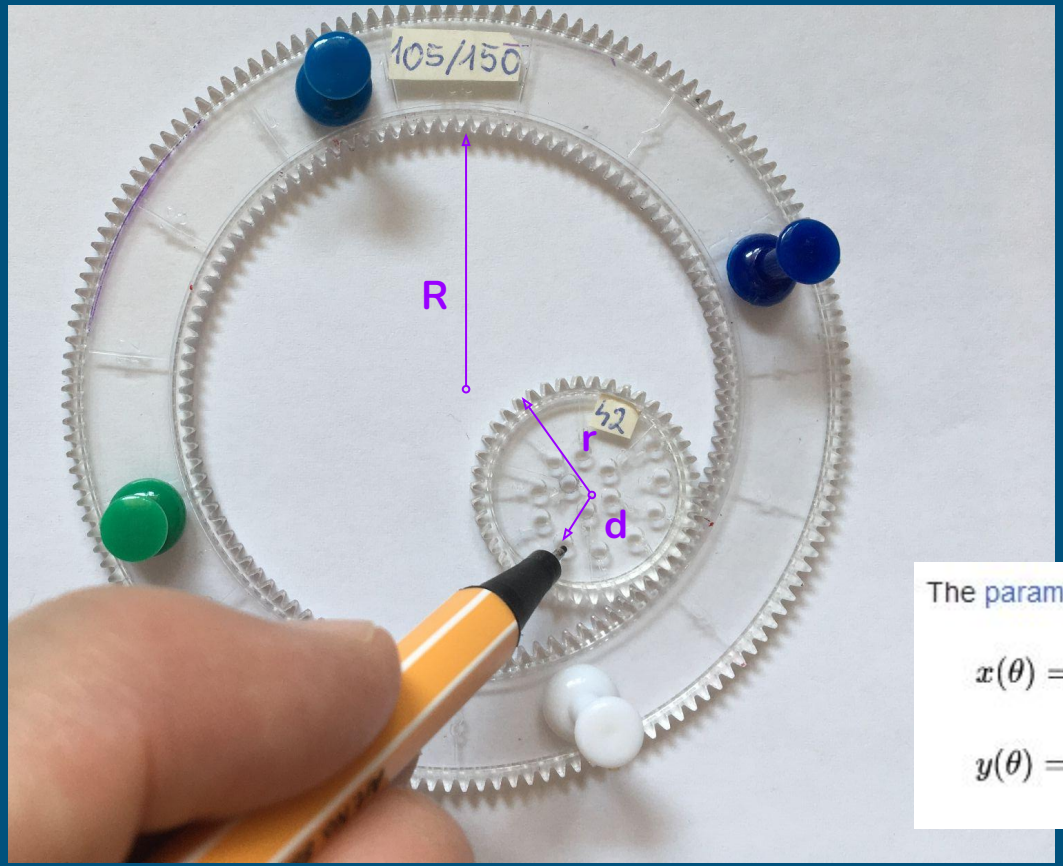
R=7, r=11, d=4



R=7, r=4, d=3



Hypotrochoid Curve ⤵



The parametric equations for a hypotrochoid are:[1]

$$x(\theta) = (R-r)\cos\theta + d\cos\left(\frac{R-r}{r}\theta\right)$$

$$y(\theta) = (R-r)\sin\theta - d\sin\left(\frac{R-r}{r}\theta\right)$$

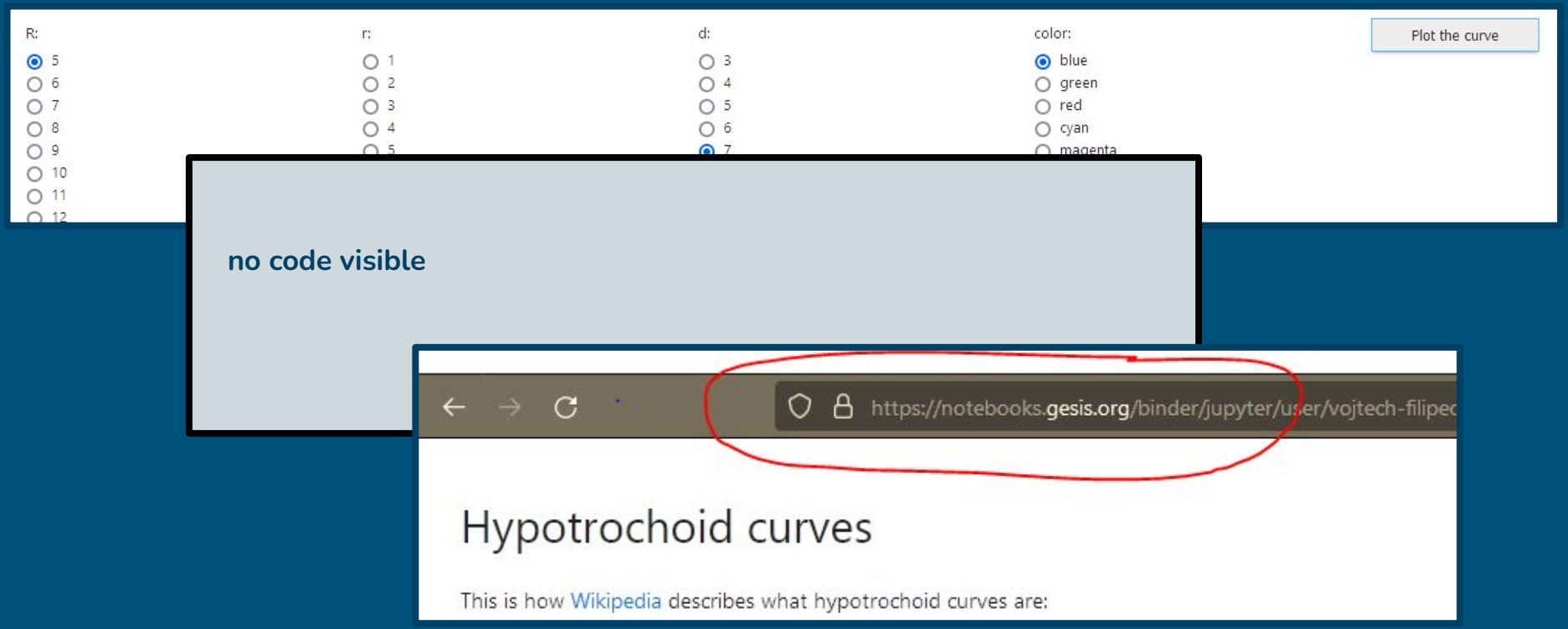
Web App via Jupyter Notebook

Live Demo

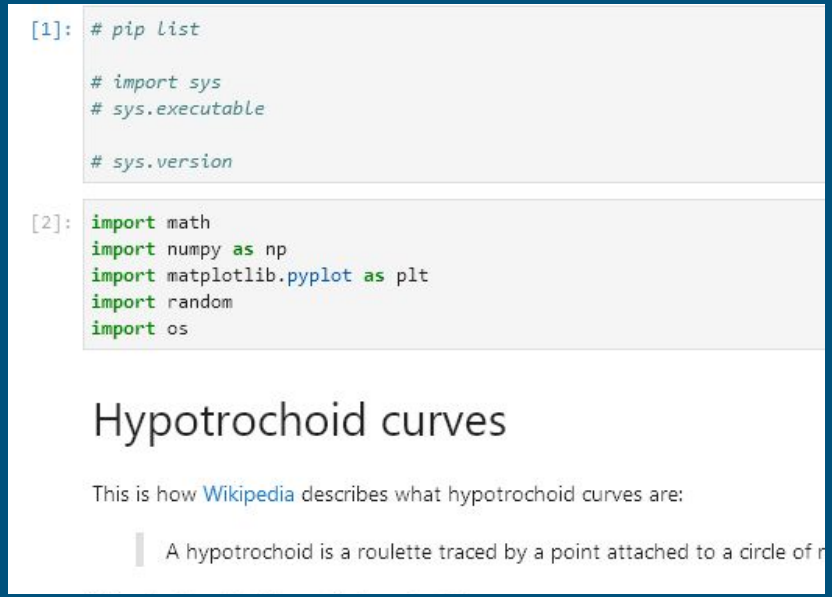
notebook: no surprise: imports, functions, markdown cells, drawing

app: github.com/vojtech-filipec -> hypotrochoid-curves -> launch Binder

Interactivity, An App Look, WWW



Interactivity: Jupyter Widgets



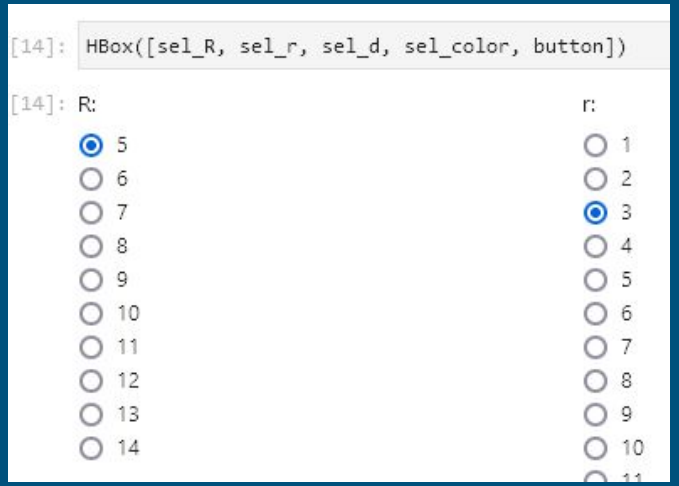
[1]:
```
# pip list

# import sys
# sys.executable

# sys.version
```

[2]:
```
import math
import numpy as np
import matplotlib.pyplot as plt
import random
import os
```

Hypotrochoid curves

This is how Wikipedia describes what hypotrochoid curves are:

> A hypotrochoid is a roulette traced by a point attached to a circle of r



[14]:
```
HBox([sel_R, sel_r, sel_d, sel_color, button])
```

[14]:

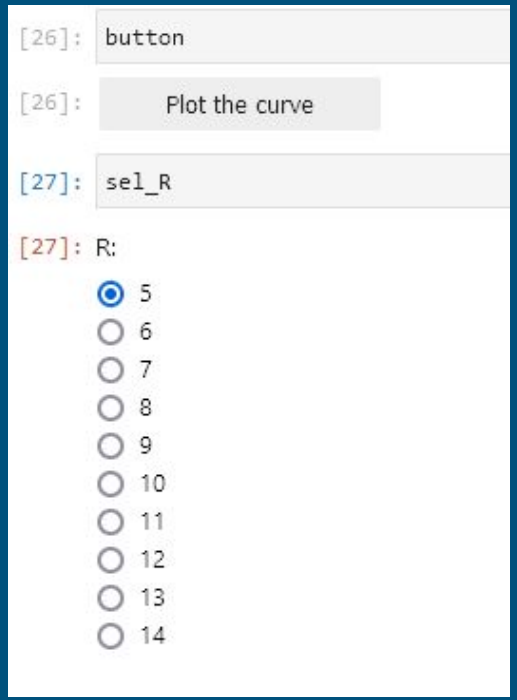
R:	r:
(•) 5	( ) 1
( ) 6	( ) 2
( ) 7	(•) 3
( ) 8	( ) 4
( ) 9	( ) 5
( ) 10	( ) 6
( ) 11	( ) 7
( ) 12	( ) 8
( ) 13	( ) 9
( ) 14	( ) 10

Interactivity: Jupyter Widgets

```
import ipywidgets as widgets
```

```
button = widgets.Button(description="Plot the curve")
```

```
sel_R = widgets.RadioButtons(
    options = list_R,
    description='R:',
    disabled=False,
    value = 5
)
```



slider, progress bar, drop-down, file selection dialogue…

https://ipywidgets.readthedocs.io/ -> Widget List

Notebook to App: **Voila**

“Voilà turns Jupyter notebooks into standalone web applications.” (readme)

two steps:

```
pip install voila
voila Curves.ipynb
```

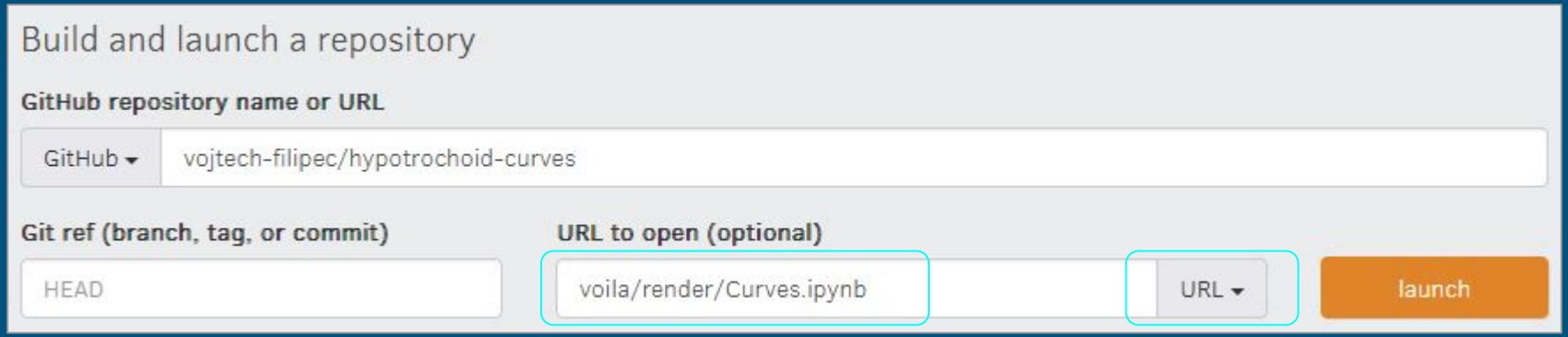
result: local run

Voila displays only cell outputs!

https://github.com/voila-dashboards/voila?tab=readme-ov-file

https://voila.readthedocs.io/en/stable/deploy.html#setup-an-example-project

World-Wide Sharing: Binder



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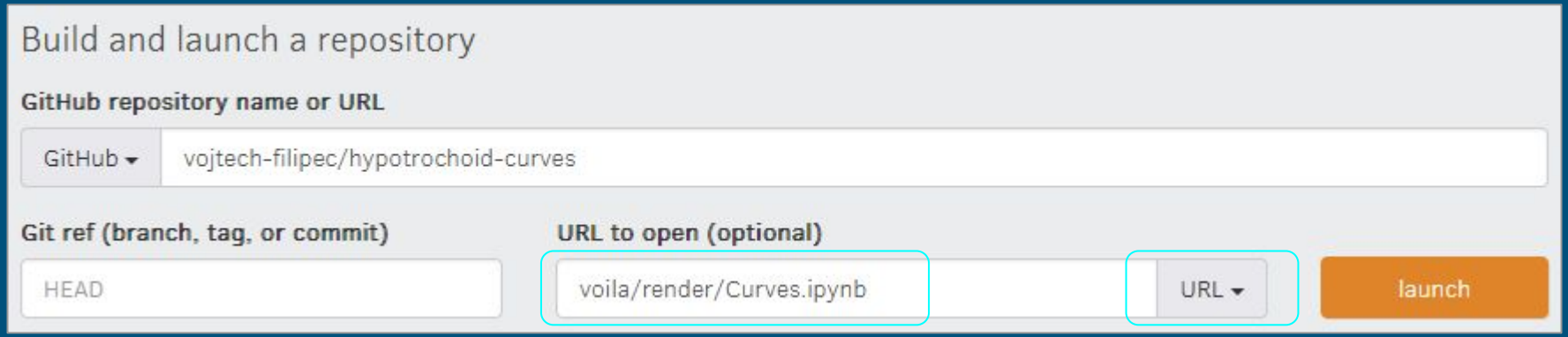


known: Binder = sharing notebooks

the killer feature: Binder supports Voila!

https://mybinder.org/

Summary: Jupyter Notebook → Web App

1. interactivity = widgets
2. notebook to app = voila
3. Binder

Alternatives

interactivity:

- pyviz panel
- marimo

  ↳ workshop on Sunday at 10am

  ↳ curves in marimo: http://feelmath.eu:2026/

  (credits: Michal Kaukič)

hosting:

https://voila.readthedocs.io/en/stable/deploy.html

Questions

Math

A **hypotrochoid** is a roulette traced by a point attached to a circle of radius *r* rolling around the inside of a fixed circle of radius *R*, where the point is a distance *d* from the center of the interior circle.

The parametric equations for a hypotrochoid are:[1]

$$x(\theta) = (R - r)\cos\theta + d\cos\left(\frac{R - r}{r}\theta\right)$$

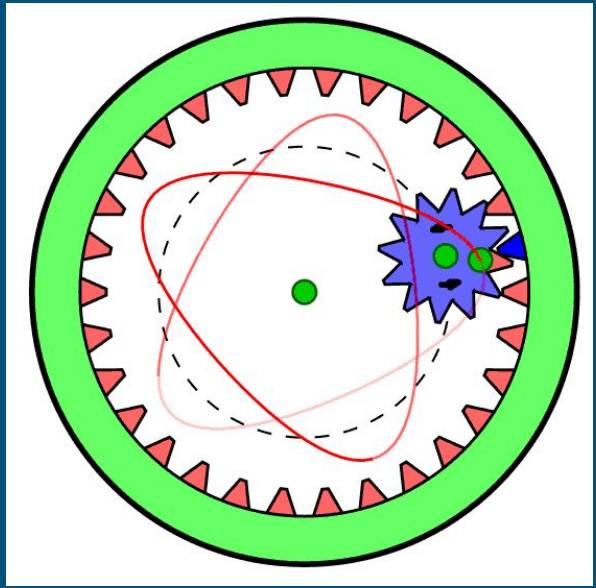
$$y(\theta) = (R - r)\sin\theta - d\sin\left(\frac{R - r}{r}\theta\right)$$

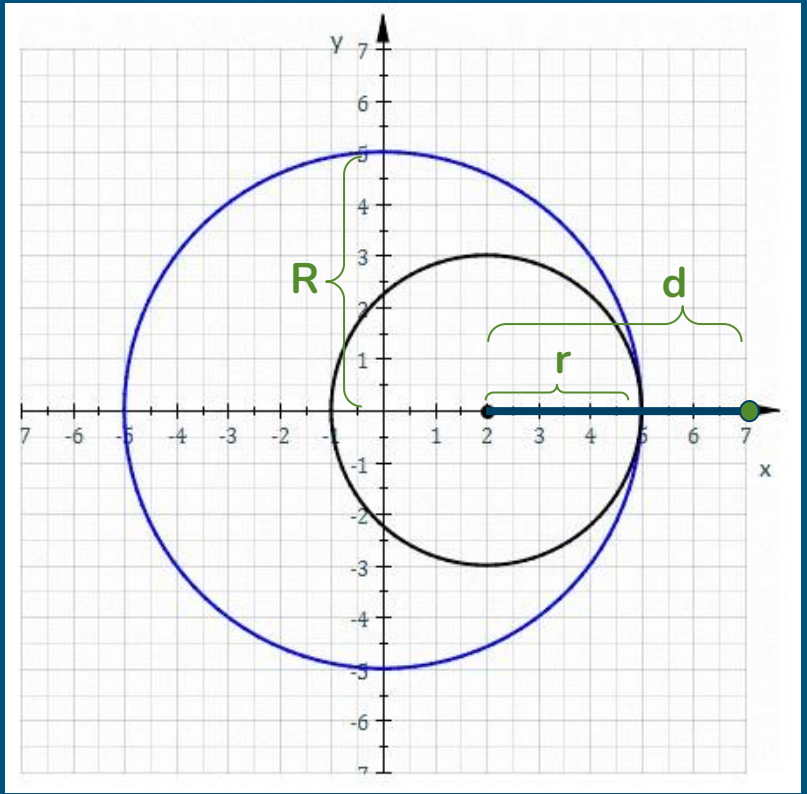
(credits: https://en.wikipedia.org/wiki/Hypotrochoid)

2019, 2022, 2024: issue with timeout:

```
Error during build:
UnixHTTPConnectionPool(host='localhost', port=None): Read timed out.
```

https://discourse.jupyter.org/t/read-time-out-error-during-push-phase/21098/4





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Math